

What is claimed is:

- 1           1. A comparative inspection device comprising:
  - 2           a stage on which an object is mounted and which moves said object;
  - 3           a detector for detecting an image of said object on said stage, said image
  - 4           comprising a plurality of inspection image regions, and for outputting an image signal;
  - 5           and
- 6           an image processing unit for receiving said image signal, determining a plurality of offsets for said plurality of inspection image regions relative to a plurality of corresponding reference image regions, and determining a selected offset out of a set of offsets of the plurality of offsets; wherein said set has at least one high reliability offset of said plurality of offsets.
- 1           2. The comparative inspection device of claim 1, wherein said plurality of corresponding reference image regions are related to a time delayed plurality of inspection image regions.
- 1           3. The comparative inspection device of claim 1, wherein said selected offset is used to align an entire inspection image and an entire reference image.
- 1           4. The comparative inspection device of claim 1, wherein a reliability of an offset of said set is a high reliability offset if a pattern on an image region of said first image regions is dense and is a low reliability offset if said pattern is sparse.
- 1           5. The comparative inspection device of claim 1 wherein a reliability of an offset of said set is evaluated by comparing said offset with a predicted offset from past variations of offsets.
- 1           6. A method for aligning comparative inspection images comprising:
  - 2           an image detection means for detecting a plurality of inspection image regions ;
  - 4           an offset determining means for detecting offsets for said plurality of inspection image regions;
  - 6           an offset selection means for determining a selected offset with a high reliability from said offsets; and

8                   an alignment means for aligning an entire inspection image and an entire  
9                   reference image using said selected offset.

1                 7.       A method for aligning a first image having a circuit pattern in a  
2                   semiconductor material with a second image, using an computer, said method  
3                   comprising:

4                   dividing said first image into a plurality of regions;  
5                   dividing said second image into a plurality of corresponding regions;  
6                   determining a first region offset of a first region of said plurality of regions  
7                   from a first corresponding region of said plurality of corresponding regions; and  
8                   using said first region offset in determining an image offset for said first  
9                   image.

1                 8.       The method of claim 7 wherein said first region offset is an offset  
2                   with a high reliability.

1                 9.       The method of claim 7 further comprising:  
2                   determining a second region offset of a second region of said plurality of  
3                   regions from a second corresponding region of said plurality of corresponding regions;  
4                   and  
5                   wherein said first region offset is used in determining said image offset for  
6                   said first image, only if said first region offset has high reliability; and  
7                   wherein said determining said image offset for said first image further  
8                   comprises, using said second region offset, if said second region offset has high  
9                   reliability.

1                 10.      The method of claim 9 further comprising:  
2                   when said first region offset and said second region offset are used in  
3                   determining said image offset for said first image, said determining said image offset for  
4                   said first image further comprises:

5                   determining a maximum correlation value using a first correlation matrix  
6                   associated with said first region offset and using a second correlation matrix associated  
7                   with said second region offset; and  
8                   selecting said image offset from a group consisting of said first region  
9                   offset and said second region, said selecting based on said maximum correlation value.

1           11. The method of claim 7 wherein, when images are received  
2 consecutively, full-image offset reliability of said image offset for said first image is  
3 evaluated and, if said full-image offset reliability is low, said first image is aligned using  
4 a past offset having a high full-image offset reliability.

1           12. The method of claim 7 wherein, when images are received  
2 consecutively, if an evaluation of full-image offset reliability for said image offset  
3 determines that full-image offset reliability is high, said image offset is stored as  
4 reference data for subsequent image alignments.

1           13. The method of claim 7 wherein, when images are received  
2 consecutively, full-image offset reliability is determined by comparing collected past  
3 offsets with high full-image offset reliability with said image offset.

1           14. A method for adjusting detection sensitivity in the inspection of  
2 images of a semi-conductor material, comprising:  
3                 determining a reliability value for an image offset of an image;  
4                 if said image offset has low reliability, evaluating if an alignment error is  
5 critical for said image; and  
6                 responsive to said evaluating, if said alignment error is critical, lowering  
7 detection sensitivity.

1           15. The method of claim 14 wherein said image offset is calculated  
2 using a plurality of region offsets, wherein a region offset of said plurality of region  
3 offsets is determined using a part of said image.

1           16. The method of claim 14 wherein said alignment error is critical,  
2 when said alignment error results in a detection error.

1           17. The method of claim 14 wherein said reliability is a full image  
2 offset reliability.

1           18. The method of claim 14 wherein said reliability value is based on a  
2 pattern density of said image.

1           19.     The method of claim 14 wherein said reliability value is based on a  
2 comparison of said image offset with a predicted offset, said predicted offset derived from  
3 past image offsets.

1           20.    The method of claim 19 wherein said predicted offset is derived  
2 using an extrapolation from a characteristic curve of past image offsets.

1           21.    The method of claim 19 wherein said predicted offset is derived  
2 using an extrapolation from a characteristic curve of past image offsets.

1           22.    A method for aligning an inspection image and a reference image,  
2 wherein a difference between said inspection image and said reference image is used in  
3 determining defects in a semiconductor material, said method comprising:

4                 partitioning said inspection image into a plurality of sub-images;  
5                 partitioning said reference image into a corresponding plurality of sub-  
6 images;

7                 forming a plurality of sub-image sets, each sub-image set comprising a  
8 sub-image of said plurality of sub-images and a corresponding sub-image of said  
9 corresponding plurality of sub-images;

10               determining a plurality of offsets for said plurality of sub-image sets;  
11               determining an image offset using a plurality of selected offsets from said  
12 plurality of offsets; and

13               aligning said inspection image with said reference image using said image  
14 offset.

1           23.    The method of claim 22 wherein said plurality of selected offsets  
2 are high reliability offsets.

1           24.    The method of claim 23 wherein a selected offset of said plurality  
2 of selected offsets is of high reliability, when a correlation matrix of said selected offset  
3 has a largest value above a predetermined threshold.

1           25.    The method of claim 23 wherein a reliability for a selected offset of  
2 said plurality of selected offsets is determined using edge information in an associated  
3 sub-image of said plurality of sub-images.

1           26. The method of claim 23 wherein a reliability for a selected offset is  
2 determined using a pattern density for an associated sub-image of said plurality of sub-  
3 images.

1           27. The method of claim 22 wherein an offset of said plurality of  
2 offsets is determined using a correlation matrix for a sub-image set of said plurality of  
3 sub-image sets.

1           28. The method of claim 27 wherein said offset is a selected offset  
2 when said correlation matrix has a largest value above a predetermined threshold.

1           29. The method of claim 22 wherein said determining said image offset  
2 using selected offsets, comprises using correlation matrices associated with said selected  
3 offsets to determine a composite correlation matrix, and using said composite correlation  
4 matrix to determine said image offset.

1           30. A comparative inspection device for aligning a plurality of images  
2 of a semiconductor wafer, comprising:

3           a detector, comprising a plurality of sensor channels, for receiving a  
4 current image of said plurality of images, wherein a sensor channel of said plurality of  
5 sensor channels receives a portion of said current image; and

6           an image processing unit coupled to said sensor channel for determining  
7 an offset between said portion of said current image and a corresponding portion of a  
8 previous image of said plurality of images.

1           31. The comparative inspection device of claim 30 wherein said offset  
2 is used in determining an alignment offset for said current image.

1           32. The comparative inspection device of claim 30, wherein said  
2 determining said offset, comprises:

3           receiving said corresponding portion by said sensor channel before said  
4 sensor channel receives said portion;

5           storing said corresponding portion in a delay memory; and

6           comparing said portion in said sensor channel with said corresponding  
7 portion from said delay memory to determine said offset.

1           33.   The comparative inspection device of claim 30, further comprising  
2   a delay memory for storing said corresponding portion.

1           34.   The comparative inspection device of claim 30, wherein said offset  
2   is a high reliability offset.

1           35.   The comparative inspection device of claim 30, further comprising:  
2                 a delay memory coupled to said plurality of sensor channels, said delay  
3   memory storing corresponding portions of a previous image;

4                 wherein said image processing unit is coupled to said delay memory and  
5   said plurality of sensor channels, said image processing unit comprising:

6                 a plurality of comparison channels, each comparison channel of said  
7   plurality of comparison channels comprising, one sensor channel of said plurality of  
8   sensor channels associated with one portion of said current image and a section of said  
9   delay memory associated with one corresponding portion of said previous image;

10                 an offset unit for determining a plurality of channel offsets for said  
11   plurality of comparison channels; and

12                 an image offset unit for determining said alignment offset for said current  
13   image, using at least one high reliability offset from said plurality of channel offsets.

1           36.   The comparative inspection device of claim 35, wherein said  
2   plurality of comparison channels operate in parallel.

1           37.   The comparative inspection device of claim 35, wherein said offset  
2   unit determines a channel offset of said plurality of channel offsets by determining a  
3   correlation matrix for a comparison channel of said plurality of comparison channels.

1           38.   A computer program product stored on a computer readable  
2   medium for aligning a first image having a circuit pattern in a semiconductor material  
3   with a second image, said computer program product comprising:

4                 code for dividing said first image into a plurality of regions;

5                 code for dividing said second image into a corresponding plurality of  
6   regions;

7           code for determining a first region offset of a first region of said plurality  
8   of regions from a first corresponding region of said corresponding plurality of regions;  
9   and  
10           code for using said first region offset in determining an image offset for  
11   said first image.